



UNIVERSITI PUTRA MALAYSIA

**THE DISTURBUTIONS OF PELAGIC FISHERY RESOURCES IN THE
STRAITS OF MALACCA AND THEIR RELATIONS TO CHANGES IN
TEMPERATURE**

MUSSE GABOBE HASSAN.

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**DOCTOR OF PHILOSOPHY
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2004



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By

MUSSE GABOBE HASSAN

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in
Fulfilment of the Requirements for the Degree of Doctor of Philosophy**

July 2004



DEDICATION

THIS WORK IS ENTIRELY DEDICATED TO MY BELOVED FAMILY:

UBAH NUR GESIE;

KHALID MUSSE GABOBE;

KHADAR MUSSE GABOBE

KHADRA MUSSE GABOBE;

AND

KHULUUD MUSSE GABOBE

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in Fulfilment of the requirement for the Degree of Doctor of Philosophy

THE DISTRIBUTIONS OF PELAGIC FISHERY RESOURCES IN THE STRAITS OF MALACCA AND THEIR RELATIONS TO CHANGES IN TEMPERATURE

By
MUSSE GABOBE HASSAN

July 2004

Chairman : Professor Mohd. Ibrahim Bin Hj. Mohamed, Ph.D.

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The pelagic fishery of Malaysia is of major economic importance because of its significant contribution to the country's fish production. This study employed four different sets of data in order to effectively model the impact of spatio-temporal characteristics of oceanographic changes on pelagic fishery in the Straits of Malacca (SOM). The study was divided into three components: (i) investigating the variations of temperature, salinity and dissolved oxygen; (ii) determining the status of small pelagic fishery resources; and (iii) modeling the impact of oceanographic changes, mainly the impacts of sea surface temperature (SST), on the distribution and abundance of pelagic fishery resources in the SOM.

The first component of this study investigated the spatio-temporal variability of physical oceanographic features, mainly sea temperature, salinity and dissolved

oxygen. Data sets from five Malacca Straits Research and Development Centre (MASDEC) oceanographic cruise expeditions conducted in the Straits of Malacca from 1998 to 2002 were rigorously analyzed. The sea surface temperature, salinity and dissolved oxygen in the SOM were found to respectively vary from 27.4 to 30.8 °C with mean (\bar{x}) of 29.1 °C, 27.6 to 33.5 ppt with mean (\bar{x}) of 31.6 ppt and 4.1 to 7.7 mg/L with mean (\bar{x}) of 6.12 mg/L.

The second component of this research investigated the status of small pelagic fishery resources in the Straits of Malacca. Fish landing reflect fluctuating patterns in the catch trends. Such patterns can be categorized into: (a) fisheries which have shown increasing trends, including indian and indo-pacific mackerel (*Rastrelliger* spp.), selar scads (*Selar* spp.), Jack-cavalla-travelly (*Carangoides* spp.), mullets (*Mugilidae*), longtail tuna and kawakawa (*Thunnus tongol* and *Euthynnus affinis*), pomfrets (*Formio niger*, *Pampus* spp), and hairtails (*Trichiuridae*) (b) fisheries which have shown decreasing trends, including round scads (*Decapterus* spp.), anchovies (*Stolephorus* spp.), sardine (*Sardinella* spp.), hardtail scads (*Megalaspis cordyla*), spanish mackerel (*Scomberomorus* spp.), barracuda (*Sphyraena* spp.) and, wolf herring (*Chirocentrus dorab*). Moreover, despite some fluctuating trends, species like hardtail scads (*Megalaspis cordyla*), anchovies (*Stolephorus* spp.), spanish mackerel (*Scomberomorus* spp.), mullets (*Mugilidae*) and wolf herring (*Chirocentrus dorab*) have been decreasing right from the determined period whereas, species like Jack-cavalla-travelly (*Carangoides* spp.) showed declining trends only in the late 1990s.

The third component of the study determined the impacts of oceanographic changes, mainly the SST, on the distributions and abundance of pelagic fishery resource in the SOM. The annual fluctuations of the availability of pelagic fishery resources in relation to SST and Southern Oscillation Index (SOI) variations have been established. The natural environmental variations, known as El Niño Southern Oscillation (ENSO) events were identified as warmer than normal temperatures and with low negative values of the SOI. The periods 1979/80, 1982/83, 1987/88, 1991/92, 1993 and 1997/98 were identified as El Niño years whereas 1978, 1984/85, 1986, 1988/89, 1995/96 and 1999/2001 were identified as La Niña years.

Barracudas, round scads, Jack-cavalla-trevally, anchovies, hardtail scads and indian mackerel showed relatively low catch values during El Niño episodes. However, the catch of wolf herring and spanish mackerel were found to be comparatively high during El Niño episodes whereas mullets, selar scads, pomfrets, sardine, longtail tuna and hairtails did not show any significant difference during the El Niño/La Niña episodes. Annual landing of purse seine net operated in the SOM from 1980-2001 showed a significant ($p<0.05$) correlation with SOI whereas the catch from trawl net did not show any apparent relationship.

Annual variability patterns between SST and Catch Per Unit Effort (CPUE) over the years showed a significant correlation indicating the CPUE to be high when the SST is high and vice versa. The results from the general linear modeling of the impacts of different SST levels and rainfall distribution on CPUE indicated that the SST was

found to be significantly ($p<0.01$) correlated with the CPUE for both purse seine and trawl nets.

The physical oceanographic phenomenon has a significant impact on the variations of fish catches, CPUE and fish density. The concept and implications of SST variability and ENSO on distributions and abundance of pelagic fishery resources in the SOM were identified and critically discussed. Based on statistical analysis, the null hypothesis that oceanographic factors have no effect on pelagic fishery resources was subsequently rejected and the alternative hypothesis was accepted. The findings obtained from this research could be very useful for not only further development and management of pelagic fishery resources in the SOM but also all in tropical waters.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**TABURAN SUMBER PERIKANAN PELAGIK DI PERAIRAN SELAT
MELAKA DAN PERKAITANNYA DENGAN PERUBAHAN SUHU**

**Oleh
MUSSE GABOBE HASSAN**

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Perikanan pelagik Malaysia mempunyai kepentingan ekonomi yang besar kerana ia adalah salah satu sumbangan kepada pengeluaran ikan negara. Kajian ini menggunakan empat set data yang berbeza-beza untuk pemprosesan yg efektif terhadap kesan ciri-ciri spatio-temporal daripada perubahan oseanografik ke atas perikanan pelagik di Selat Melaka. Kajian ini terbahagi kepada tiga komponen iaitu: (i) menyelidik variasi daripada suhu, saliniti dan oksigen terlarut; (ii) menentukan status sumber perikanan pelagik kecil, dan (iii) menghasilkan model bagi kesan perubahan oseanografik, terutamanya kesan suhu permukaan air laut, terhadap taburan dan kelimpahan sumber perikanan pelagik di Selat Melaka.

Komponen pertama kajian ini telah mengkaji variabiliti spatio-temporal ciri-ciri fizik oseanografik, sebahagian besar mengenai suhu air, saliniti dan kandungan oksigen

terlarut. Lima ekspedisi laut MASDEC (Pusat Penyelidikan dan Pembagangungan Selat Melaka) yang dijalankan dari tahun 1998 hingga 2002 telah menganalisis kaedah-kaedah ini secara menyeluruh. Suhu permukaan air laut, saliniti dan oksigen terlarut di Selat Melaka masing-masing antara 27.4 °C hingga 30.8°C dengan purata (\bar{x}) 29.1°C; 29.3 hingga 33.1 ppt dengan purata (\bar{x}) 30.4 ± 1.0 ppt, dan 4.1 hingga 7.7 dengan purata (\bar{x}) 6.12 mg/L.

Komponen kedua kajian ini telah mengkaji status sumber perikanan pelagic kecil di Selat Malaka. Ciri-ciri *dorata* ikan menunjukkan pola yang turunaik dalam tren tangkapan. Pola sedemikian dapat dikategorikan kepada (a) Perikanan yang menunjukkan tren peningkatan, termasuklah kembong (*Rastrelliger* spp.), aya (*Thunnus tongol* and *Euthynnus affinis*), selar kuning (*Selar* spp.), cermin (*Carangoides* spp.), belanak (*Mugilidae*), bawal hitam (*Formio niger*, *Pampus* spp) dan timah (*Trichiuridae*) dan (b) Tangkapan yg menunjukkan tren penurunan termasuklah selayang (*Decapterus* spp.), bilis/bunga air (*Stolephorus* spp.), tamban sisek (*Sardinella* spp.), cencaru (*Megalaspis cordyla*), tenggiri (*Scomberomorus* spp.), alu-alu (*Sphyraena* spp.) dan parang- parang (*Chirocentrus dorab*). Tamban pula, walaupun terdapat kadar turunaik yang tidak menentu, spesies seperti belanak (*Mugilidae*), cencaru (*Megalaspis cordyla*), bilis (*Stolephorus* spp.), parang- parang (*Chirocentrus dorab*) dan tenggiri (*Scomberomorus* spp.) telah menunjukkan penurunan dari awal lagi dalam tempoh kajian manakala spesies seperti cermin dan selar hanya menunjukkan penurunan pada akhir tahun 1990an.

Komponen ketiga kajian pula mengkaji kesan perubahan oseanografik, terutamanya suhu permukaan, taburan dan kelimpahan sumber perikanan pelagik di Selat Melaka. Turun naik tahunan pada ketersediaan sumber perikanan pelagik sehubungan dengan perubahan pada suhu permukaan air laut dan Index Hayunan Selatan (SOI) telah ditentukan. Perubahan semulajadi alam sekitar yang dikenali sebagai peristiwa Hayunan Selatan El Niño (ENSO) telah dikenal pasti sebagai suhu persekitaran yang lebih tinggi dari suhu persekitaran normal dan dengan nilai negatif rendah Index Hayunan Selatan (SOI). Yang rendah dan negative jangkamasa 1979/80, 1982/83, 1987/88, 1991/92, 1993, dan 1997/98, telah dikenalpasti sebagai jangkamasa El Niño manakala jangkamasa 1978, 1984/85, 1986, 1988/89, 1995/96 dan 1999/2001 telah dikenalpasti sebagai jangkamasa La Niña.

Alu-alu, selayang, cermin, bilis, cencaru dan kembong secara relatifnya mempunyai kadar tangkapan yang rendah semasa berlakunya fenomena El Niño. Namun tangkapan ikan jenis parang-parang dan tenggiri adalah lebih tinggi semasa episod El Niño tetapi belanak, selar kuning, bawal, tamban sisik, aya (tongkol/hitam) dan timah tidak menunjukkan sebarang perubahan ketara dalam sepanjang episod El Niño atau La Niña. 'Pukat jerut' yang beroperasi di Selat Melaka dari tahun 1980-2001 menunjukkan korelasi yang ketara dengan SOI sedangkan tangkapan pukat tunda pula tidak menunjukkan sebarang hubungkait yang jelas.

Sejak bertahun-tahun membuat kajian mengenai pola perubahan bermusim antara suhu permukaan air laut dan Usaha Tangkapan Per Unit (CPUE), ia menunjukkan korelasi yang ketara di mana apabila nilai CPUE tinggi maka suhu permukaan juga

turut tinggi dan sebaliknya jika suhu permukaan rendah. Keputusan pemodelan linear umum terhadap kesan mod suhu yg berbeza-beza permukaannya dan kadar taburan hujan ke atas CPUE menunjukkan bahawa suhu permukaan mempunyai kolerasi statistik yang ketara dengan CPUE untuk kedua-dua pukat jerut ('purse seine net') dan pukat tunda. Perbandingan hanya dilakukan untuk melihat kesan terhadap variasi tahunan suhu permukaan dan dari sini dapat dibuat kesimpulan bahawa hipotesis hubungan TPUU dengan suhu permukaan adalah kukuh. Walaupun begitu, pada masa ini, mekanisma hipotetikal yang menerangkan hubungan tersebut tidak dapat dijelaskan.

Fenomena oseanografik fizikal didapati mempunyai kesan penting terhadap variasi dalam penangkapan ikan, Usaha Tangkapan Per Unit (TPUU) dan kepadatan ikan. Konsep dan implikasi perubahan suhu permukaan laut dan Hayunan Selatan El Niño ke atas taburan dan kelimpahan perikanan pelagik yang dinamik di Selat Melaka telah berjaya dikenal pasti dan dibincangkan secara kritikal. Berdasarkan kepada analisis statistik, terdapat hipotesis yang kurang jelas yang menyatakan faktor-faktor oseanografik tidak memberi kesan ke atas sumber perikanan pelagik telah berjaya dibuktikan secara tidak sah dan hipotesis alternatif telah diterima. Hasil yang diperolehi dari kajian ini amatlah berguna dalam perikanan pelagik di Selat Melaka.

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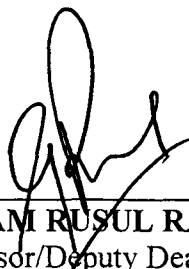
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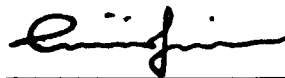
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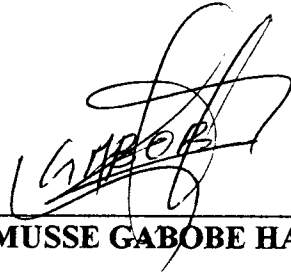
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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degrees at UPM or other institutions.



MUSSE GABOBE HASSAN

DATE: 26 July, 2004

TABLE OF CONTENTS	Page
DEDICATION	III
ABSTRACT	IV
ABSTRAK	VIII
ACKNOWLEDGMENTS	XVI
APPROVAL	XIV
DECLARATION	XVI
LIST OF FIGURES	XX
LIST OF TABLES	XXIX
LIST OF ABBREVIATIONS	XXXI

CHAPTER	Page
I INTRODUCTION	01
Background of the Research	01
General Information about Pelagic Fishery	07
Oceanographic Phenomenon of the SOM	08
GIS for Marine Environment	10
Problem Statement	12
Significance of the Study	14
Scope and the Objectives	15
Hypothesis	16
II LITERATURE REVIEW	17
Pelagic Fishery	17
Fluctuations in Pelagic Fish Stocks	18
The Peruvian Anchoveta	19
The Atlanto-Scandian Herring	20
Pilchard and Anchovies	20
Adriatic Sardine and Anchovies	21
Oceanographic Variations and Pelagic Fishery	28
Modes of Influence in Physical Oceanography On	
Pelagic Fishery	30
Temperature	31
Temperature as an Indicator of Changes in the Sea	32
The Impact of Temperature on Pelagic Fish Stocks	33
Salinity	35
Dissolved Oxygen	37
Climatology Conditions of the Straits	38
Surface Winds	43
Current	44



Chlorophyll-a/Sea Colour	45
Upwelling	47
Characteristics of El Niño Southern Oscillations	48
Hydroacoustic Methods for Fish Abundance	50
Advances of GIS in Marine Environment	51
Multivariate Analysis in Pelagic Fishery	54
Correlation and Regression Analysis	56
Discussion	58
III GENERAL METHODOLOGY	59
Study Area	59
Topography	60
Data Source	61
Fishery Data (Fish Catch Landing Data)	61
Acoustic Data	65
MASDEC Oceanographic Expeditions	65
Meteorological Data	69
COADS Datasets	70
Other Datasets	71
Methods of Analysis	71
Fishery Analysis and Modelling	72
CPUE Analysis	72
General Linear Modelling	72
GIS Analysis	74
Importing the Data	74
Spatial Analysis	77
Inverse Distance Weighing (IDW)	78
Spline Interpolation Method	78
Materials (Hardware and Software)	79
IV CHARACTERIZATIONS OF SPATIO-TEMPORAL VARIABILITY OF PHYSICAL OCEANOGRAPHIC FEATURES	80
INTRODUCTION	80
MATERIALS AND METHODS	82
Study Area	82
Data Collection	83
Data Analysis	83
Statistical Analysis	83
RESULTS	86
Spatio-temporal Variations of Temperature	86
Sea Surface Temperature Distribution at 0.5m	86
Temperature Distribution at 10m	93
Spatio-temporal Variability of Salinity	97

	Sea Surface Salinity Distribution at 0.5m	97
	Salinity Distribution at 10m	102
	Spatio-temporal Variability of Dissolved Oxygen	106
	Sea Surface Dissolved Oxygen Distribution at 0.5m	106
	Dissolved Oxygen Distribution at 10m	107
	DISCUSSION	108
V	STATUS OF SMALL PELAGIC FISHERY RESOURCES IN THE SOM	116
	INTRODUCTION	116
	METHODS	118
	RESULTS	119
	Seasonal Fish Catch Analysis, 1979-2001	119
	Analysis in Chronological Changes of Small Pelagic Fishery	121
	Hierarchical Cluster and Box-and-whisker Plot Analysis	123
	Distributions in Catch (mt) of Indian Mackerel	123
	Distributions in Catch (mt) of Anchovies	127
	Distributions in Catch (mt) of Round Scads	131
	Distributions in Catch (mt) of Selar Scads	134
	Distributions in Catch (mt) of Hardtail Scads	138
	Distributions in Catch (mt) of Sardine	141
	Distributions in Catch (mt) of Spanish Mackerel	145
	Distributions in Catch (mt) of Pomfrets	148
	Distributions in Catch (mt) of Longtail Tuna	152
	Distributions in Catch (mt) of Hairtails	155
	Distributions in Catch (mt) of Wolf Herring	159
	Distributions in Catch (mt) of Mulletts	162
	Distributions in Catch (mt) of Jack-cavalla-trevally	166
	Distributions in Catch (mt) of Barracudas	169
	Principal Component Analysis	172
	DISCUSSION	176
VI	SPATIO-TEMPORAL VARIABILITY OF OCEANOGRAPHIC FEATURES AND THEIR IMPACTS ON DISTRIBUTIONS OF PELAGIC FISHERIES IN THE SOM	182
	INTRODUCTION	182
	METHODOLOGY	185
	Catch Per Unit Effort (CPUE)	185
	Analysis Methods	187
	General Linear Modeling	188
	RESULTS	190
	Analysis of the Impact of SST Variations on Fish Catch	190
	Analysis of the Impact of SST Variations on CPUE	195
	Distribution and Abundance of Pelagic Fishery and their Relations to SST	203

Analysis of Impacts of El Niño on Pelagic Fishery Resources	211
DISCUSSION	223
VII GENERAL DISCUSSION AND CONCLUSION	234
BIBLIOGRAPHY	247
APPENDICES	270
BIODATA OF THE AUTHOR	291

LIST OF FIGURES

Figure	Page
1. A typical purse seiner boat that operates in the SOM	05
2. A typical trawl net which operates in the SOM	05
3. The catches of Peruvian anchoveta from 1950 to 2000	22
4. The catches of Atlanto-Scandian herring from 1950 to 2000	23
5. The catches of pilchard and anchovy in Chile and Peru from 1950 to 2000	23
6. The catches of pilchard and anchovy in Japan from 1950 to 2000	24
7. The catches of pilchard and anchovy in Southern Africa from 1950 to 2000	24
8. Landings of anchovies at major Italian ports from 1975 to 1999	25
9. Landings of sardines at major Italian ports from 1975 to 1999	25
10. Pelagic-demersal landing of Western and East Adriatic Sea and Global fishery during 1972 to 1997	26
11. Italian landing of top pelagic species and other selected species	26
12. Annual catch landings of top pelagic species from Albania, Croatia, Slovenia and, Yugoslavia from 1972 to 1997	27
13. Annual catch landings of anchovy form 1975 to 1996 in the northern and central Adriatic	27
14. Annual catch landings of sardine form 1975 to 1996 in the northern and central Adriatic	28
15. Distribution of water masses and current in the Straits of Malacca and South China Sea during the Northeast monsoon season	42
16. Distribution of water masses and current in the Straits of Malacca and South China Sea during the southwest monsoon season	42



17. Map of the Study Area	60
18. Map of the Straits of Malacca with MASDEC Sampling Points	82
19. Spatial distributions of sea surface temperature (°C) at 0.5m during the first MASDEC expedition	90
20. Spatial distributions of sea surface temperature (°C) at 0.5m during the second MASDEC expedition	91
21. Spatial distributions of sea surface temperature (°C) at 0.5m during the third MASDEC expedition	91
22. Spatial distributions of sea surface temperature (°C) at 0.5m during the fourth MASDEC expedition	92
23. Spatial distributions of sea surface temperature (°C) at 0.5m during the fifth MASDEC expedition	92
24. Spatial distributions of sea temperature (°C) at 10m during the first MASDEC expedition	95
25. Spatial distributions of sea temperature (°C) at 10m during the second MASDEC expedition	95
26. Spatial distributions of sea temperature (°C) at 10m during the third MASDEC expedition	96
27. Spatial distributions of sea temperature (°C) at 10m during the fourth MASDEC expedition	96
28. Spatial distributions of sea temperature (°C) at 10m during the fifth MASDEC expedition	97
29. Spatial distributions of sea surface salinity (ppt) at 0.5m during the first MASDEC expedition	99
30. Spatial distributions of sea surface salinity (ppt) at 0.5m during the second MASDEC expedition	100
31. Spatial distributions of sea surface salinity (ppt) at 0.5m during the third MASDEC expedition	100
32. Spatial distributions of sea surface salinity (ppt) at 0.5m during the fourth MASDEC expedition	101

33.	Spatial distributions of sea surface salinity (ppt) at 0.5m during the fifth MASDEC expedition	101
34.	Spatial distributions of sea salinity (ppt) at 10m during the first MASDEC expedition	103
35.	Spatial distributions of sea salinity (ppt) at 10m during the second MASDEC expedition	103
36.	Spatial distributions of sea salinity (ppt) at 10m during the third MASDEC expedition	104
37.	Spatial distributions of sea salinity (ppt) at 10m during the fourth MASDEC expedition	104
38.	Spatial distributions of sea salinity (ppt) at 10m during the fifth MASDEC expedition	105
39.	Spatial distributions of sea surface temperature (°C) in the Andaman Sea during northeast monsoon	112
40.	Spatial distributions of sea surface salinity (ppt) in the Andaman Sea during northeast monsoon	113
41.	Spatial distributions of sea temperature (°C) at 1-10m in the Gulf on Thailand and East Coast of PM during September, 1995	113
42.	Spatial distributions of sea salinity (ppt) at 1-10m in the Gulf on Thailand and East Coast of PM during September, 1995	114
43.	Time series analysis trends in catch (MT) by dominant small pelagic species from the SOM, 1976-2001	122
44.	Time series analysis trends in total catch (mt) of indian mackerel from the SOM during 1979-2001	124
45.	Spatio-temporal distributions in catch (mt) of indian mackerel in the SOM, 1979-2001	125
46.	Annual state catch landing analysis using Hierarchical Cluster by Ward's method with Euclidean distances of indian mackerel landing from the SOM during 1979-2001	126
47.	Annual state catch landing analysis using Box and Whisker plot of indian mackerel landing from the SOM during 1979-2001	127



48.	Time series analysis trends in total catch (mt) of anchovies from the SOM during 1979-2001	128
49.	Spatio-temporal distributions in catch (mt) of anchovies in the SOM, 1979-2001	129
50.	Annual state catch landing analysis using Hierarchical cluster by Ward's method with Euclidean distances of anchovies landing from the SOM during 1979-2001	130
51.	Annual state catch landing analysis using Box and Whisker plot of anchovies landing from the SOM during 1979-2001	130
52.	Time series analysis trends in total catch (mt) of round scads from the SOM during 1979-2001	132
53.	Spatio-temporal distributions in catch (mt) of round scads in the SOM, 1979-2001	132
54.	Annual state catch landing analysis using Hierarchical cluster by Ward's method with Euclidean distances of round scads landing from the SOM during 1979-2001	133
55.	Annual state catch landing analysis using Box and Whisker plot of round scads landing from the SOM during 1979-2001	134
56.	Time series analysis trends in total catch (mt) of selar scads from the SOM during 1979-2001	135
57.	Spatio-temporal distributions in catch (mt) of selar scads in the SOM, 1979-2001	136
58.	Annual state catch landing analysis using Hierarchical cluster by Ward's method with Euclidean distances of selar scads landing from the SOM during 1979-2001	137
59.	Annual state catch landing analysis using Box and Whisker plot of selar scads landing from the SOM during 1979-2001	137
60.	Time series analysis trends in total catch (mt) of hardtail scads from the SOM during 1979-2001	139
61.	Spatio-temporal distributions in catch (mt) of hardtail scads in the SOM, 1979-2001	139